Marten use of clear-cuttings and residual forest stands in western Newfoundland

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Marten (*Martes americana*) inhabit primarily old-growth coniferous and mixed wood forest habitats. Widespread forest harvest operations have prompted inquiries into whether residual patches of forest left after harvesting, or regenerating clear-cuttings, provide adequate habitat for marten. In western Newfoundland, the primary method of tree harvest has been clear-cutting of large tracts of balsam fir (*Abies balsamea*) and black spruce (*Picea mariana*). The only remaining populations of marten in the province also are found in the western part of the island, with greatest densities near Little Grand Lake. This study was designed to determine if marten used regenerating clear-cuttings and small remnant patches of residual forest left after forest operations. Habitat use by marten was investigated by livetrapping and snow tracking. Residual stands were classified into five size categories, and clear-cuttings into three categories based on height of balsam fir regeneration. From June to December 1983, marten were trapped in 43 residual stands and 35 clear-cuttings. A total of 3587 trap nights yielded 57 captures of 10 male and 8 female marten. Six (10.5%) captures were in clear-cuttings, all <15 years old; 51 (89.5%) marten were captured in residual stands. Capture rates were 0.48 captures/100 trap nights in the clear-cuttings and 2.19 captures/100 trap nights in residual stands. Capture rates were greatest in residual stands 25 to 34.9 ha in size (4.62 captures/100 trap nights). From January to March 1984, marten tracks were followed for 29 km. Although clear-cuttings represented 41% of the study area, only 26% of marten travel was recorded there, all in clear-cuttings <15 years old. Residual stands >25 ha and undisturbed forest composed 41.3% of the study area; 41.8% of marten travel was recorded there. Smaller residual areas (<25 ha) made up only 4.2% of the total area, but 32.4% of the marten travel was recorded in these areas. These data indicate that marten seldom used clear-cuttings and used residual stands >25 ha and undisturbed forests in proportion to their occurrence, but the use of smaller residual stands <25 ha was greater than expected.

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Les Martres (*Martes americana*) habitent de préférence les vieilles forêts de conifères et les forêts mixtes. Les opérations de déboisement ont atteint un telle importance qu'il est devenu nécessaire de savoir si les ilôts d'arbres laissés en place ou les régions de coupe à blanc en regénération fournissent aux martres des habitats adéquats. Dans l'ouest de Terre-Neuve, le déboisement se fait surtout par coupe à blanc sur de grandes surfaces des Sapins baumiers (*Abies balsamea*) et des Epinettes noires (*Picea mariana*). Les seules populations de martres qui restent se trouvent aussi dans l'ouest de l'île, les plus denses près de Little Grand Lake. Cette étude a été entreprise dans le but de savoir si les martres utilisent les régions complètement déboisées en regénération et les petits ilôts d'arbres laissés en place après les opérations de déboisement : des pièges destinés à capturer les animaux vivants et l'examen des pistes dans la neige ont servi à cette fin. Les bois résiduels ont été classifiés en cinq catégories et les régions déboisées entièrement, en trois catégories, selon la taille des sapins qui ont repoussé. De juin à décembre 1983, les martres ont été piégées en 43 bois résiduels et 35 régions complètement déboisées. Les 3587 pièges-nuits ont donné lieu à 57 captures de 10 mâles et 8 femelles : six (10,5%), dans des régions déboisées depuis moins de 15 ans et 51 (89,5%), dans des forêts résiduelles. Les taux de capture ont été évalués à 0,48 capture/100 pièges-nuits en forêt déboisée et 2,19 captures/100 pièges-nuits en forêt résiduelle. Les taux étaient particulièrement élevés dans les forêts résiduelles de 25–34,9 ha (4,62 captures/100 pièges-nuits). De janvier à mars 1984, les pistes des martres ont été suivies sur une distance de 29 km. Les forêts entièrement coupées constituaient 41% de la surface d'étude, mais seulement 26% des déplacements des martres y ont été enregistrés, toujours dans des régions déboisées depuis moins de 15 ans. Les forêts résiduelles de plus de 25 ha et les forêts intactes couvraient 41,3% de la surface étudiée et 41,8% des déplacements y ont eu lieu. Les forêts résiduelles moins grandes (<25 ha) ne constituaient que 4,2% de la surface totale, mais 32,4% des déplacements des martres y ont été constatés. Ces données indiquent que les martres n'utilisent que rarement les régions complètement déboisées et utilisent les ilôts d'arbres laissés intacts de plus de 25 ha et les forêts non touchées proportionnellement à leur disponibilité, mais l'utilisation des petits ilôts d'arbres de moins de 25 ha s'est avérée plus importante que prévue.

[Traduit par la revue]

Introduction

Marten inhabit primarily undisturbed, dense coniferous or mixed forest in Canadian and Hudsonian life zones throughout North America. Loss of large areas of old-growth coniferous habitat because of harvesting and fire, and excessive trapping of marten have been cited as major reasons for their decline in distribution and numbers in some parts of North America in the past (Koehler and Hornocker 1977; Mech and Rogers 1977); however, there are no data to suggest that populations are currently declining across North America. Marten had a wide distribution in most forested regions of Newfoundland; however, they are now restricted to isolated areas of mature forest in

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the western part of the province (Bergurud 1969). Although marten were once trapped commercially in Newfoundland, Skinner (1979) reported that they were never abundant. The marten trapping season was closed in 1934 because of declining populations. Despite complete protection since then, marten numbers and distribution have not increased markedly. Limited prey base, coupled with accidental trapping and snaring, as well as habitat alteration may be responsible.

The Newfoundland Wildlife Division conducted a distribution study in 1982 and 1983, and showed that the Little Grand Lake area is one of the few areas that contain a remnant marten population. Bateman (1982) investigated habitat use by marten in winter in western Newfoundland and reported that marten preferred old-growth balsam fir (*Abies balsamea*) – black spruce (*Picea mariana*) and balsam fir – white birch (*Betula papyrifera*) forests with dense overhead cover. Studies conducted elsewhere in North America have shown that timber harvesting, especially clear-cutting, is detrimental to marten populations. Marten densities in commercially clear-cut areas in Maine were one-third of those in partially cut and undisturbed forests (Soutiere 1979). These same clear-cuttings were seldom used in winter, probably because of poor hunting conditions for marten due to lack of access to subnivian space (Steventon and Major 1982). In a short-term study in Montana, Campbell (1979) reported that marten did not use clear-cuttings during the 1st year after timber harvesting. In Ontario, marten were 2 to 3 times more abundant in undisturbed forests than in cutover areas (Thompson 1982).

This study investigated some of the effects of timber harvesting in western Newfoundland to determine if marten use of habitat was influenced by (*i*) stage of regeneration of clear-cuttings or (*ii*) size of residual stands.

Study area

The 140-km^2 study area was located in western Newfoundland, adjacent to Little Grand Lake and approximately 50 km south of the town of Corner Brook. Approximately 18.6 km^2 of the area was composed of water and barrens and these were excluded in the analyses. Topography was moderately rugged, with steep slopes extending from naturally barren hilltops that ranged from 300 to 2000 m to river valleys and low areas. The area was within the Corner Brook section of the Boreal Forest Region of Canada (Rowe 1972). The dominant tree species were balsam fir, black spruce, and white birch. Regenerating clear-cuttings were dominated by white birch, red maple (*Acer rubrum*), and raspberry (*Rubus idaeus*) until balsam fir became established.

Annual temperatures in this region average 5°C, with a January mean of −6°C and a July mean of 17°C. Total annual precipitation averages 1150 mm and mean annual snowfall is about 520 cm. (Weather information is based on Atmospheric Environmental Service, Department of Environment summaries for Stephenville.)

From 1960 to 1983, forests in this area were extensively clear-cut. Most accessible softwood timber was removed, leaving only scattered birch trees and unmerchantable softwood stands. These stands, or residuals, often isolated from other patches of uncut forest, were between 1 and 270 ha, and comprised 16% of the total area. Clear-cuttings, ranging in size to 1600 ha, comprised 41% of the total area. Cutover areas were extensive because the harvesting pattern involved clear-cutting contiguous to the previous year's cut. Thirty percent of the total area was composed of undisturbed forest where harvesting had not yet occurred, 7% was naturally barren, and 6% was water.

The study area was part of a larger region established in 1973 by the Newfoundland Wildlife Division to protect marten. Trapping and snaring of all species are prohibited in this region.

Methods

Field work was conducted from June 1983 to March 1984. In the summer and fall of 1983, marten use of residual stands and clear-cuttings was investigated by livetrapping. Snow tracking was used for more detailed investigations of habitat use by marten during the winter.

Habitat categories

Residual stand area was classed into five categories based on size: <5.0, 5.0–14.9, 15.0–24.9, 25.0–34.9, and >35.0 ha. Undisturbed forest was included in the residual stand category >35.0 ha. Clear-cuttings were classified into three categories based on the height of balsam fir regeneration: (1) balsam fir <1 m high, generally <8 years after harvesting; (2) balsam fir 1–2 m high, stand age 8–15 years; (3) balsam fir >2 m high, stand age 16–23 years. The height of balsam fir regeneration was used as an index of vegetation regeneration because it is (*i*) the dominant species present on the regenerating clear-cuttings, and (*ii*) the species of primary importance in providing the overhead cover considered to be important to marten (Hawley and Newby 1957; Herman and Fuller 1974).

Summer and fall

Trapping

Trapping was conducted from June to December 1983 in 43 residual stands and 35 clear-cuttings using the methods of Soutiere (1978). Traps were set at 100-m intervals along parallel transects spaced 300 m apart in the residual stands, and extending at least halfway into the adjacent clear-cutting. An attempt was made to sample each category in proportion to its occurrence on the study area. Each site was trapped for 6 consecutive days. On initial capture, marten were immobilized with 100 mg of ketamine hydrochloride (100 mg/cm^3) to facilitate handling. Each animal was ear-tagged and weighed, and age and sex were determined (Marshall 1951; Newby and Hawley 1954). A first premolar tooth was extracted from each marten for aging by cementum analysis. On subsequent recaptures tag numbers were recorded.

Trap site characteristics

At each trap site, the following information was recorded: forest type, dominant overstory species, percent overhead cover, average tree height, average tree dbh (diameter at breast height), major understory and ground cover species, distance to nearest different habitat, distance to nearest water, slope, aspect, occurrence of slash, fallen trees, and snags, and category of clear-cutting or size of residual stand.

Analysis

Chi-square analysis was used to test for differences in captures between residual stands and clear-cuttings, and among residual stand categories. Stepwise logistic regression was used to analyze habitat data recorded at each trap site to determine which variables accounted for the differences between successful and unsuccessful trap sites. Stepwise logistic regression was also used to determine habitat differences between residual stands and clear-cuttings, among clear-cutting categories, and among residual stand categories. Tree, understory, and ground vegetation species at successful and unsuccessful trap sites were examined for differences (FUNCAT procedure, SAS Institute 1982).

Winter

Snow stations

Snow depths and profiles were measured at six stations; one in each of the three clear-cutting categories, and three in residual stands. Each station consisted of four substations, with stakes calibrated in centimetres for depth measurements. All were read at least once a week and a snow profile was dug weekly.

Tracking

All residual stands and clear-cuttings in which marten had been trapped were searched for marten tracks. Additional clear-cuttings, residual stands, and forested areas were also searched and marten tracks followed. Direction of travel, activity class, habitat type, topography category, tracks of other species encountered, snow condition, and sinking depth were also recorded. Marten tracks were followed until snow conditions deteriorated or tracks were lost.

TABLE 1. Marten captures in clear-cuttings and residual stands

Habitat type category	No. of sites	Trap nights	Marten captures	Captures/ 100 trap nights
Clear-cutting height				
<1 m	20	746	5	0.67
1–2 m	10	432	1	0.23
>2 m	5	82	0	0
Subtotal	35	1260	6	0.48
Residual stands				
<5.0 ha	15	286	2	0.70
5.0–14.9 ha	10	308	3	0.97
15.0–24.9 ha	5	239	6	2.51
25.0–24.9 ha	6	303	14	4.62
>35.0	7	1191	26	2.18
Subtotal	43	2327	51	2.19
Total	78	3587	57	1.60

Analysis

Habitat selection by marten in winter was determined by comparing distance of marten trails observed in each habitat with an expected distance based on the area of each habitat available in the study area. A chi-square goodness of fit test was used. For each habitat type, use was compared with availability using a preference index (alpha vector) developed as a stochastic model by Chesson (1978) after Manly's (1973) intuitive model. This index was calculated as:

$$\sum_{i=1}^{m} \alpha_i = r_i n_i^{-1} \left(\sum_{j=1}^{m} r_j n_j^{-1} \right)^{-1}$$

where r_i = proportional use of habitat i, n_i = proportional availability of habitat i, and m = number of habitat types.

Possible values range from zero to one. Strongly avoided habitats have positive values less than $1/n$ where n = the number of available habitat types (here 8, i.e., $1/n = 0.125$) and strongly selected habitats show positive values greater than $1/n$.

Results

Summer and fall

Ten male and 8 female marten were caught in 3587 trap nights, with 39 recaptures, for a total of 57 captures (Table 1).

Captures in residuals versus clear-cuttings

Capture rates of marten were greater in residual stands than in clear-cuttings (χ^2 = 15.10, df = 1, $P < 0.001$). Fifty-one (89.5%) of the marten captures were in residual stands and six (10.5%) were in clear-cuttings. Mean captures per 100 trap nights (C/100TN) were 2.19 C/100TN in all residual stands and 0.48 C/100TN in clear-cuttings. Residual stands 25–34.9 ha had 4.62 C/100TN. Capture rates in Ontario averaged 2.26 C/100TN in uncut forest and 1.09 C/100TN in clear-cuttings, based on 57 captures of 29 marten in 1892 trap nights (Thompson 1982). Other studies have shown significant reductions in marten densities in clear-cut areas when compared with partially cut or undisturbed forests (Campbell 1979; Soutiere 1979); however, trapping was not conducted specifically in residual stands for a comparison of marten use of these areas.

Captures in clear-cuttings

Only six marten were captured in clear-cuttings in 1260 trap nights. Five of the captures were in category 1 clear-cuttings, harvested in 1978 and 1981, with balsam fir regeneration less than 1 m in height. One marten was captured in a category 2 clear-cutting, harvested in 1976, with regeneration between 1 and 2 m high. Because of the small sample size, it was not possible to analyze these data for variation among clear-cutting categories. The small sample size was a result of limited use of clear-cuttings by a sparse marten population.

Marten may have taken advantage of temporary increases in prey abundance in the young clear-cuttings. One- to 15-year-old clear-cuttings in Maine had more small mammals, particularly meadow voles (*Microtus pennsylvanicus*) and masked shrews (*Sorex cinereus*), than did undisturbed softwood stands (Monthey 1978). Meadow voles and masked shrews are the available and important marten prey in Newfoundland (Bateman 1982). Recent captures of *Peromyscus* suggest an additional prey species may be available but its abundance is as yet unknown. One trapline in a 10-year-old clear-cutting was less productive for meadow voles and masked shrews than the forest trapline (Bateman 1982). We were able to find no other data on how clear-cutting in Newfoundland forests affects the limited prey base available to marten. Although prey *abundance* may not be affected by forest harvesting, the *availability* of small mammals, primarily meadow voles and masked shrews, may decrease, especially in winter (Koehler and Hornocker 1977). In the summer, dense plant growth may decrease marten hunting success by increasing escape cover for prey (Steventon and Major 1982). Difficulty in prey capture may partially account for marten avoidance of clear-cuttings.

There were no marten captured in category 3 clear-cuttings, even though they were more extensive than the younger ones and approached a stage of regeneration that seemed to provide good marten habitat, although they had fewer residual stands. Category 3 clear-cuttings were located at the western end of the study area and sustained the greatest amount of human activity throughout the year. Thinning was conducted in some of these clear-cuttings from July to September 1983 and was sometimes within 1 km of trapping transects. We were unable to determine if these disturbances influenced marten use of the immediate area. Soutiere (1979) found that active woods operations did not cause marten to shift home range or affect movements of transients.

Weckwerth and Hawley (1962) suggested that juvenile marten may be forced to move to less favorable, unoccupied areas because they are unable to compete with resident adults. More captures of juvenile marten than adults were expected in clear-cuttings, especially in the late summer and fall when juveniles were dispersing. However, no juveniles were captured in Little Grand Lake clear-cuttings, only 1-, 2-, 3-, and 11-year-old animals. All were recaptured at other times in residual stands in the same general area, and were probably resident marten and not transients travelling through the area.

Soutiere (1979) reported that male marten travelled more extensively in commercial clear-cut forest than did females. He captured 12 marten in clear-cuttings, but only 1 was a female. In this study, two male and three female marten were captured in clear-cuttings.

Captures in residual stands

Trapping in 43 residual stands resulted in 51 captures in 2333 trap nights. Marten capture rates differed with residual stand size, with more captures in the larger residual stands (χ^2 = 13.36, df = 4, P = 0.010) (Table 2). Only 5 (10%) of 51 captures were in residual stands <15 ha. Thirteen captures would be expected if marten use was independent of residual stand size. Therefore, actual use is less than half of that expected. The smaller residual stands were usually more isolated from undisturbed forest and often consisted of small

TABLE 2. Distribution of marten captures by residual stand size

Residual stand size (ha)	Trap nights	% of effort	Captures: Observed	Captures: Expected	Chi-square value
<5.0	286	12.3	2	6.3	2.93
5.0–14.9	308	13.2	3	6.7	2.04
15.0–24.9	239	10.3	6	5.3	0.09
25.0–34.9	303	13.0	14	6.6	8.30
>35.0	1191	51.2	26	26.1	0
Total	2327	100.0	51	51.0	13.36[a]

[a] $P = 0.010$.

patches of scrubby black spruce or balsam fir. Large residual stands were frequently on the edges of large clear-cuttings in areas such as steep slopes that were inaccessible to harvesting equipment.

Residual versus clear-cut habitat

Stepwise logistic regression showed tree height, percent overhead cover, presence of slash, and distance to the nearest habitat edge to be the variables contributing most to the difference between residual and clear-cut trap sites. Species of trees and dominant ground vegetation did not differ between clear-cut and residual trap sites, although raspberries were more common in clear-cuttings of categories 1 and 2.

Marten have been recorded foraging in clear-cuttings for raspberries in late summer, indicating that they may exploit this seasonal food source in marginal habitat (Steventon and Major 1982). Soutiere (1979) found raspberry seeds in 22% of marten scats from the late summer, suggesting a seasonal shift in habitat use at this time. Newfoundland marten were captured in clear-cuttings on 28 June; 4 August; 10, 11, 18 October; and 24 November 1983. Only one of these captures was during raspberry season (mid-July to late August). However, several marten scats found in July and August consisted almost entirely of raspberry seeds. Raspberries may be an important food source for a short period of time, but this study did not show a shift into more open habitat by marten during this season.

Clear-cutting habitat

There were 6 successful and 211 unsuccessful trap sites in the clear-cuttings. Habitat did not vary among clear-cutting categories except in height of regeneration. Stepwise logistic regression showed that none of the trap site variables had predictive value in clear-cuttings.

Residual habitat

Stepwise logistic regression analysis of habitat variables of the 46 successful and 359 unsuccessful residual trap sites indicated that tree dbh was the only variable that contributed significantly to differences in trapping success; however, mean dbh did not differ with size of residual stands. Average tree dbh >15 cm was preferred by marten in the residual stands. Successful trap sites in residual stands <15 ha were closer to water but farther from habitat edges than those in residual stands >15 ha. On average, overhead cover was usually denser and trees were usually taller in small residual stands. White birch was more common in large residual stands. Despite these differences, the major factor influencing marten use of residual stands was the size of the residual.

Total habitat

When all successful (52) and unsuccessful (570) trap sites were analyzed with stepwise logistic regression, percent overhead cover and tree dbh were the only predictors of trapping success. Overhead cover averaged 50–100% and dbh, >15 cm at successful trap sites. Tree and ground vegetation species did not differ between successful and unsuccessful trap sites.

Winter

Snow stations

Winter fieldwork was conducted from January to March 1984. Average snow depths were 89.9 cm in residual stands and 108.4 cm in clear-cuttings. Category 1 clear-cuttings had the lowest mean depth. Strong winds were common and probably accounted for the lower snow depths since much of the snow was blown away. However, by late February, category 1 clear-cuttings were completely snow covered with no vegetation or slash visible above the snow. Balsam fir regeneration up to 3 m above snow level in the category 3 clear-cuttings provided 75–100% overhead cover, accounting for a lower average snow depth. Overhead cover in category 2 clear-cuttings was insufficient to influence snow depth.

Until mid-February, there was little or no powder snow over a firm crust of 1 to 5 cm. From late February to late March, average powder snow accumulation increased. Snow fell almost daily in March, making tracking difficult.

Tracking

Marten tracks were followed for 29.0 km (Table 3). Marten frequented residual stands and undisturbed forest. Seventy-four percent of marten trails were located in forested habitats, which comprised 46% of the total area. Clear-cuttings represented 41% of the study area but only 25% of marten travel was recorded there. Frozen ponds, barrens, and category 3 clear-cuttings were not used by marten.

Category 1 and 2 clear-cuttings were used less than expected, and the preference index value was very low, indicating avoidance by marten. Category 3 clear-cuttings were avoided totally. Residual stands up to 25 ha were selected, although stands <5 ha were used randomly while those 5 to 24.9 ha were highly preferred. Residual stands >25 ha and uncut forest were used less than expected. This inconsistency with the pattern in the rest of the residual stands is probably because deteriorating weather conditions often hindered tracking in these habitats. Although the tracks continued, we could no longer follow them. This resulted in less distance being recorded than existed, and produced negative electivity index values indicating avoidance by marten. Tracks in smaller residual patches were followed more easily in a shorter period of time.

Travel patterns differed between clear-cuttings and residual stands. Trails in clear-cuttings were usually in a relatively straight line, from one residual stand to another. Conversely, trails in forested habitats were often in a zig-zag and looped

TABLE 3. Distribution of marten trails among habitat

Habitat category	% of study area	Proportional availability (n_i)[a]	Travel distance (km) Expected	Observed	Proportional use (r_i)[b]	Alpha-vector index
Clear-cuttings						
1	13.9	16.0	4.04	4.30	14.86	0.038
2	15.3	17.7	4.41	3.17	10.94	0.026
3	12.0	13.8	3.47	0	0	0.000
Residual stands[c]						
5.0	1.0	1.2	0.30	1.04	3.59	0.124
5.0–14.9	2.0	2.3	0.57	2.70	9.31	0.167
15.0–24.9	1.2	1.4	0.35	5.65	19.51	0.575
25.0–34.9	1.4	1.6	0.42	0.83	2.86	0.074
35.0 and uncut forest	39.9	46.0	11.55	11.27	38.93	0.035
Water	6.5		1.89	0	0	
Barrens	6.8		1.96	0	0	
Total	100.00	100.0	28.96	28.96	100.00	

[a]Percentage of available habitat; does not include water or barrens.
[b]Percentage of total travel (km) in these habitats.
[c]Categories of residual stands based on size in hectares.

pattern. In Maine, marten have been tracked across clear-cuttings as wide as 200 (Soutiere 1978) and 300–400 m (Steventon 1979). Hargis and McCullough (1984) recorded a marten travelling 135 m across a meadow in California. During this study, marten crossed openings 20–600 m wide, with an average of 150 m. Eighty-seven percent of crossings were less than 250 m.

We recorded "stops" and "investigations" while tracking. Stops consisted of urination, defecation, and scent marking locations, and instances when marten paused briefly while travelling. Locations where marten tracks disappeared into the snow in a hole at the base of a tree or stick, or where the marten dug at the snow surface were classified as investigations. Sixty-eight stops and 130 investigations were recorded while martens were being tracked. Seventy-nine percent of the stops and 79% of the investigations were in forested habitats. Investigations were often associated with trees, sticks, or slash protruding above the snow, and with tracks of other species, especially snowshoe hare (*Lepus americanus*) and red squirrel (*Tamiasciurus hudsonicus*).

No marten tracks were found in category 3 clear-cuttings. Overhead cover was between 50 and 100% in unthinned areas. Approximately half of these clear-cuttings had been thinned and trees were spaced 3 m apart, reducing overhead cover to <25%. Tracks of snowshoe hares and red squirrels were relatively abundant in these clear-cuttings, but small mammal sign was not evident. Bateman (1982) reported that, based on scat analysis, the most important prey species of marten in winter were snowshoe hare and meadow vole. Apparent lack of availability or abundance of small mammal prey in clear-cuttings may be an important reason for limited use of these areas by marten, but requirements for cover may also be involved.

Discussion

Low densities of marten continue to inhabit the Little Grand Lake area despite extensive clear-cutting of mature forest. Because marten in the area are sparse and their use of clear-cuttings is limited, sample sizes were too small to detect if variation in use of clear-cuttings was correlated with the stage of vegetation regeneration. Ten percent of marten captures in the summer and fall were in clear-cuttings <15 years old and characterized by balsam fir regeneration <2 m high. Marten were not captured in older clear-cuttings 16 to 23 years after harvesting. During the winter, 26% of marten trails were in clear-cuttings up to 15 years old. No tracks were observed in older clear-cuttings.

Residual stands <35 ha composed 6% and residual stands >35 ha and undisturbed forest, 40% of the study area, yet 90% of all captures were in forested areas; 9% were in residual stands <15 ha, 35% were in residuals of 15–34.9 ha, and 46% were in larger stands. In the winter, 74% of all travel was in forested habitats, 32% in residual stands <25 ha, and 42% in undisturbed forest and residuals >25 ha. Residuals <25 ha had a proportional availability of 4.9% (n_i) but were proportionally used (r_i) 32.4%, whereas with larger residuals, n_i = 47.6% and r_i = 12.1%. Residuals of 15 to 24.5 ha appear to be most preferred during winter while during summer and fall, trapping indicated that residuals of 25 to 34.9 ha were most frequently used. These data demonstrate clearly that larger residual and undisturbed stands (>15 ha) are important habitat components for marten in extensively clear-cut areas. Areas with less forested habitat can be expected to support lower marten densities. Successful trap sites usually had trees with dbh at least 15 cm and overhead cover of 50 to 100%. No other trap site variables were important when analyzed by stepwise logistic regression.

A more intensive study of marten use of clear-cuttings is necessary to document the stage of regeneration that will provide adequate habitat for marten. Our data suggest that 23 years after timber harvesting is still insufficient time in this area, but this may not be true elsewhere, where growth is more rapid and there are different cover species. Overhead cover, small mammal availability and abundance, and resting and denning sites are critical factors for marten (Steventon and Major 1982), and these appeared to be lacking in the regenerating clear-cuttings we studied. Residual stands and areas of undisturbed forest can provide these important habitat components and may enable at least a remnant marten population to survive despite clear-cutting. If large clear-cuttings continue to be the predominant method of forest harvesting in western Newfoundland, with clear-cutting of contiguous areas year after year, available habitat and the populations that depend on them will continue to decline, and recovery to previous levels cannot be expected.

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